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BUILDABILITY IN BRIDGE CONSTRUCTION:  
CASE STUDY OF SUNGAI JOHOR CABLE-STAYED BRIDGE

MARDIYAH ZAHIDI

A project report submitted in partial fulfillment of the  
requirements for the award of the degree of  
Master of Science (Construction Management)

Faculty of Civil Engineering  
Universiti Teknologi Malaysia

NOVEMBER 2009

I declare that this project entitled “Buildability in Bridge Construction: Case Study of Sungai Johor Cable-stayed Bridge” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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TO:

*Tok Wan*  
*My beloved parents,*  
*Zahidi Yazid and Rodah Mohd Noor;*  
*My dearest brothers*  
*Zainal Zahidi & Kamili Zahidi*  
*Thank you for being in my life*

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## ABSTRACT

Nowadays, construction projects are becoming much more complex and difficult which include the bridge project. Thus, delay in project duration and overrun in project cost becomes a common occurrence which sometime the quality and safety aspect also been affected. Previous studies show that one of the contributing factors is the weaknesses of design produced by the designer. Meanwhile, buildability is the extent to which the design of a building facilitates ease of construction, subject to the overall requirements for the completed building. This study identified the problems occurred in one case study, Sungai Johor cable-stayed Bridge, that was conducted through site visit, interviews and questionnaire. Then, the problems were categorized into design related and non-design related problems. From the case study, it showed that the number of identified design related and non-design related problems are almost similar in form of number of occurrence. The case study also revealed that the impact of poor buildability is severe toward cost and duration of project, followed by quality. Other impacts which are less significant include safety and environment. This study has successfully established design phase buildability guideline for cable-stayed bridge construction. The guideline will help the construction people to ensure the implementation of buildability concept in their project and improve the project performance.

## ABSTRAK

Pada masa kini, projek pembinaan menjadi semakin kompleks dan sukar termasuklah projek pembinaan jambatan. Akibatnya projek sering gagal disiapkan dalam masa dan kos yang telah diperuntukkan, dan kadang aspek kualiti dan keselamatan projek turut terganggu. Kajian terdahulu menunjukkan bahawa salah satu faktor penyumbang kepada kekompleksan sesebuah projek adalah datangnya dari fasa rekaan. Sementara itu, kebolehbinaan adalah lanjutan daripada mereka sesebuah bangunan yang memudahkan pembinaan, merujuk pada keperluan bagi penyiapan sepenuhnya bangunan. Kajian pada kali ini bertujuan bagi mengenalpasti masalah yang timbul dalam satu kajian kes, Jambatan kabel-penahan Sungai Johor, dengan mengadakan lawatan, wawancara dan soal selidik. Masalah-masalah ini kemudiannya dikategorikan samada masalah berkaitan rekaan atau tidak berkaitan rekaan. Dari kajian ini, didapati masalah berkaitan rekaan yang timbul adalah sama banyak dengan masalah tidak berkaitan rekaan yang timbul. Hasil kajian juga menunjukkan bahawa kesan dari masalah berkait rekaan yang timbul adalah kritikal terhadap kos dan tempoh projek, dan diikuti oleh kualiti projek. Selain itu, kesan lain yang kurang parah ialah keselamatan dan alam sekitar projek. Diakhir kajian ini, satu senarai panduan bagi kebolehbinaan projek jambatan pada peringkat rekaan telah berjaya dihasilkan. Panduan ini diharapkan dapat membantu pihak yang terlibat dalam pembinaan bagi memastikan konsep kebolehbinaan diterap ke dalam projek mereka dan seterusnya dapat meningkatkan mutu projek.



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## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

Bridge is a structure linking between two places, built to avoid obstacle underneath it such as rivers, lakes, streets and etc, but without blocking the existing way of traffic underneath it. Long ago, bridge is perceived as mere connector but the concept of bridge today has many meanings. It may regard as the country landmark due to its aesthetic value such as the Goltzsch Valley Bridge, in German which claimed as the eighth wonder of the world, and the Isfahan bridge which distinguish as the pearl of Islam (Graf, 2002).

The bridges also symbolically represent the country reputation which may indicate the higher level of architectural and engineering of the country. There are quite a number of bridges that has been erected in Malaysia but the Penang Bridge had made Malaysian proud till today (Figure 1.1). The total length of the bridge is 13.5km, clustering it among the longest bridge in the world ([www.en.wikipedia.org](http://www.en.wikipedia.org)).

Different type of bridges has been erected since its appearance many centuries ago. Some of the examples are the continuous girder bridge which is the simplest to build and inexpensive one; cantilever bridge, arch bridge, and suspension bridge. The

most popular typology recently is cable-stayed bridge which appears to be more economical for a long span bridge.



**Figure 1.1:** The Penang Bridge ([www.en.wikipedia.org](http://www.en.wikipedia.org)).

Buildability can be defined as the extent to which the design of a building facilitates ease of construction, subject to the overall requirements for the completed building (CIRIA, 1983). The buildability concept was first emerged in United Kingdom in 1970s, which then attract others countries to carry out more studies on this concept.

Singapore is the pioneer country conducting research on buildability in Asia region, where they come out with Minimum Buildability Score under Buildable Design Appraisal System (BDAS) scheme (BCA, 2004). The contractors are required to score higher for project commissioning approval. In Malaysia, there were already some studies that have been made on buildability but still a lot more are needed to be applied in construction industry.

The previous studies made in US, UK, Australia and Singapore had proved that by applying buildability concept in construction, it will help in saving the project cost and time (Griffith and Sidwell, 1997; Francis et al., 1999). Meanwhile, Kevin (1995) cited that most of buildability concepts were applied in the Burlington Bridge and it is considered as a successful bridge because the completion date is within the schedule time and also budget.

## **1.2 Problem Statement**

Nowadays, construction projects are becoming much more complex and difficult, that includes the bridge project. With the emergence of new technology and construction method of bridge, the designers and the contractors are burdened with the lack of experience and knowledge to implement. Thus, delay in project duration and increment in project actual cost becomes a common occurrence in the construction industry which sometime the quality and safety aspect also been affected. These situations actually do not arise only in the new method of construction but also in the typical project.

From various studies conducted, there are many factors contribute to project delay and cost increment but mostly due to variation of work by the designer. They are lack of buildability knowledge where only a few concepts of buildability were applied during design phase. Meanwhile, the buildability had been proved that it can enhance cost efficiency and quality of construction project (Trigumasyah, 2004).

## **1.3 Aim and Objectives of the Study**

The objectives of this study are as followed;

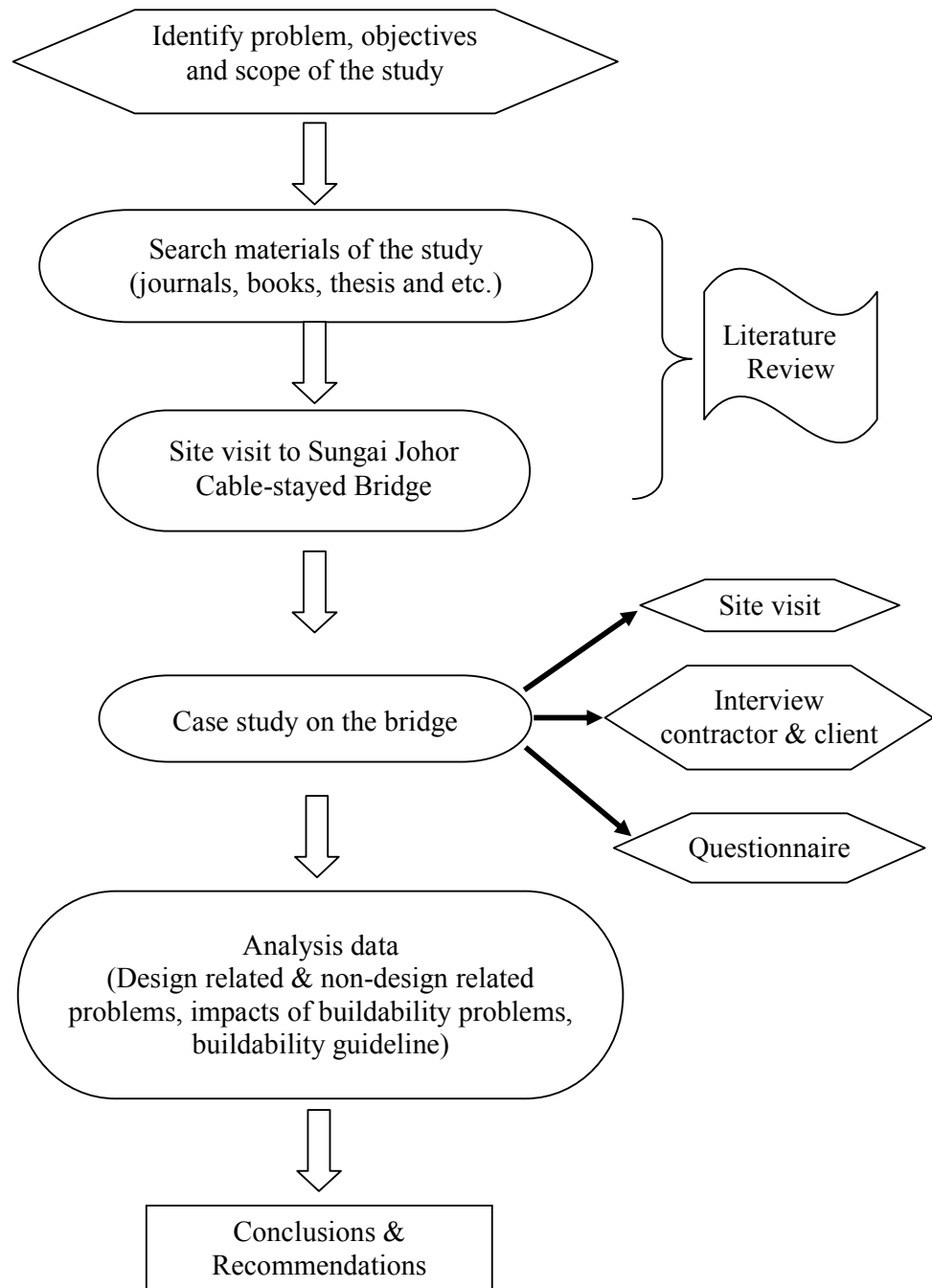
- i) To identify and document design related and non-design related problems in cable-stayed bridge construction
- ii) To identify impact of poor design buildability in cable-stayed bridge construction
- iii) To establish design phase buildability guideline for cable-stayed bridge construction

The aim of this study is to assist the bridge designer in implementing buildability principles in their design by referring to the guideline.

#### **1.4 Scope of the Study**

The scope of this study is about the new cable-stayed bridge near Masai which is known as Sungai Johor Bridge. The bridge is a part of Senai-Pasir Gudang-Desaru-Expressway (SPGDE). The bridge is chosen because it is still under construction and near to Skudai, so it will be easier to get the information on the application of buildability concept in the construction. Besides, SDE is one of mega project in Malaysia which involve large amount of parties and money. The information related to the study is collected from previous journals, thesis and books. The data of study are about one case study of the Sungai Johor Bridge and are obtained based on the methodology elaborated in Chapter 3.

## 1.5 Flowchart of the Study



**Figure 1.2:** Flowchart of the study.